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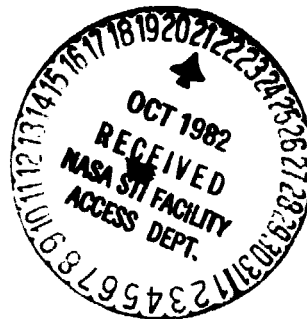
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SEASAT-A SASS WIND

PROCESSING

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I. Introduction

The following pages briefly describe the techniques used in work which Ocean Data Systems, Inc. has been doing for Fleet Numerical Oceanography Center for ingesting SEASAT-A SASS wind retrievals into the existing operational software.

The intent is to assess the impact of SEASAT data in the marine wind fields produced by the global marine wind/sea level pressure analysis. This analysis is performed on a $2\frac{1}{2}^{\circ}$ latitude/longitude global grid which executes at three hourly time increments. Comparisons of wind fields with and without SASS winds are being made.

The Jet Propulsion Laboratory is continuing this study by funding experiments of driving the Spectral Ocean Wave Model with the resulting wind fields. Comparisons of the output will be made with Altimeter data, also received from SEASAT-A.

The problems of data volume reduction and aliased wind retrieval ambiguity are treated as described in the following sections.

II. Production of SUPEROB Input

The JPLSASS program converts SASS reports from the JPL format to a format compatible with FNOC requirements, to be incorporated into SUPEROB generation. This program also performs some alteration on the SASS reports to alleviate the aliasing problem caused by multiple wind solutions for the same observation. The concept is to reduce the number of possible solutions from a maximum of four to a maximum of two solutions which are approximately in opposite directions from each other. It should then be easier to later discard the one solution which departs the most from the guess field.

If there are more than two solutions for a report, the techniques for reducing the number of solutions to two are as follows:

For three solutions, if any two solutions have directions within a specified angle of each other, then the directions and wind speeds of these two solutions

are averaged with equal weight. The modified report then consists of the averaged direction and speed plus the remaining solution which was not included in the average. If the angular criterion is not met by any of the solutions the report is discarded.

For four solutions, if any two solutions have directions within a specified angle of each other, then the directions and wind speeds of these two solutions are averaged with equal weight. The directions and wind speeds of the remaining two solutions are also averaged regardless of their angle with equal weight. The modified report then consists of these two averaged solutions. If the angular criterion is not met by any solutions, the report is discarded.

For a special data set provided by JPL, it was estimated that for a specified angle of 40°, only about 10% of the SASS reports with more than two solutions would be accepted. For wider angles, the acceptance increased significantly. Computer runs show that 56% of the reports were accepted for 50°, 68% for 60°, and 84% for 70°. Preliminary tests are being made using 60° as the acceptance angle.

In the following description of the production of SUPEROBS, one should remember that references of up to four solutions is reduced to a maximum of two solutions as a result of the JPLSASS processing.

III. Production of the SUPEROBS

A SUPEROB is a pseudo-report which is generated at a gridpoint and represents a weighted average of one or more SASS reports. The contribution of a SASS observation to this composite is specified by its weight and is proportional to (1) the time difference between the observation and the analysis (range = ± 90 minutes) and (2) the distance between the locations of the SASS report and the SUPEROB. A SASS report is only incorporated into the SUPEROB at the closest gridpoint.

Since each SASS report consists of between one and four solutions for both the wind speed and direction, there are several ways to utilize this information. Five options have been included in the subroutine SUPEROB and the particular method to be used is specified via sense switches which are set prior to program execution.

In Option 1 each of the (up to four) SASS wind speed solutions is multiplied by the report's weight (see above) and added to the cumulative total for that SUPEROB location. Thus, each of the possible four solutions has the same contribution. The wind speed is a weighted average of all SASS report solutions at the gridpoint location.

$$(\text{SUPEROB Speed})_{1,J} = \frac{\displaystyle\sum_{k=1}^{NSASS} \left(\sum_{\ell=1}^{NSOL} w_k * SPDSASS_\ell \right)}{\displaystyle\sum_{k}^{NSASS} \left(\sum_{\ell=1}^{NSOL} w_k \right)}$$

1,J	=	gridpoint locations
where NSASS	=	number of SASS reports close to gridpoint I,J
NSOL	=	number of solutions for (SASS report)$_k$
w_k	=	weight of (SASS report)$_k$
$SPDSASS_\ell$	=	a speed solution for (SASS report)

When all of the SASS reports have been processed, a weighted average for the wind speed is obtained at each gridpoint. This averaged speed is coupled with the wind direction which has been taken from the guess wind field, to create a SUPEROB report.

NOTE: When the SASS instrument is looking straight down at the nadir point, the wind direction is considered to be unresolvable. In such cases, the SASS report will have only one solution, with the wind direction set to zero. The wind speed is still valid, however. Since option 1 is the only option which does not utilize the SASS wind direction, these nadir reports are included in the average only for this option, and rejected for all others.

For Option 2, the procedure is the same as in Option 1 except that the weighted average procedure is used for both the wind direction and the wind speed. The direction solutions are averaged as above, so that:

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$$(\text{SUPEROB Direction})_{i,j} = \frac{\sum\limits_{k=1}^{NSASS} \left(\sum\limits_{\ell=1}^{NSOL} w_k * DIRSASS_\ell \right)}{\sum\limits_{k=1}^{NSASS} \left(\sum\limits_{\ell=1}^{NSOL} w_k \right)}$$

where $DIRSASS_\ell$ = a direction solution for (SASS report)

In this case, then, each of the SASS wind direction solutions contributed to the final SUPEROB direction. Due to the method of retrieval of SASS obs, this option should not be used unless retrievals have been reduced to one solution only (i.e. if the aliasing problem is solved externally).

In Option 3 each of the wind direction solutions is compared to the guess field wind direction. The solution which is <u>closest to the guess wind field direction</u> is assumed to be the correct solution. Only this direction and its corresponding wind speed solution are incorporated into the average of the SUPEROB location. For one particular SASS report, the first step in the processing is to determine which solution is the closest in direction to the guess field, i.e.:

$DIRSASS_k$ = SASS solution such that

$$\left| DIRGFD - DSASS_n \right| \quad \text{is the minimum}$$

for $\leq 1 \leq n$ number of solutions
in $(\text{SASS report})_k$

$DIRGFD$ = direction of guess field

The SUPEROB is a weighted average of the SASS reports which are closest to a particular gridpoint. Thus:

$$(\text{SUPEROB Direction})_{i,j} = \frac{\sum\limits_{k=1}^{NSASS} \left(w_k * DIRSASS_k \right)}{\sum\limits_{k=1}^{NSASS} w_k}$$

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where

I,J	=	gridpoint locations
NSASS	=	number of SASS reports for which I,J location represents the nearest gridpoint
w_k	=	weight for (SASS report)$_k$, a function of distance from gridpoint and time lag.
DIRSASS$_k$	=	is defined above.

Similarly, the speed is a weighted average of the "best" solution, i.e:

$$(\text{SUPEROB Speed})_{I,J} = \frac{\displaystyle\sum_{k=1}^{\text{NSASS}} \left(w_k * SPDSASS_k \right)}{\displaystyle\sum_{k=1}^{\text{NSASS}} w_k}$$

where SPDSASS$_k$ = SASS speed solution corresponding to the DIRSASS$_k$ solution.

NOTE: In the actual calculation of a wind direction a running average is done rather than dividing two sums. This method is utilized due to the problem of averaging wind directions which are close in direction, but degree values are quite different (e.g. 355° and 10°). If the difference between the two angles is greater than 180°, then 360 is added to the smaller angle before the averaging is done. (In the example, the 10° solution is changed to 370°.) Once the new average is found, it will have 360 subtracted if it exceeds 360°.

The running average is an average which is determined with each new addition to the solution at a particular gridpoint.

Thus:

$$\text{DIRECTION}_k = \left(\frac{\sum\limits_{\ell=1}^{k-1} w_\ell}{\sum\limits_{\ell=1}^{k} w_\ell} \right) * \text{DIRECTION}_{k-1}$$

$$+ \left(\frac{w_k}{\sum\limits_{\ell=1}^{k} w_\ell} \right) * \text{DIRSASS}_k$$

where

DIRECTION_k = new weighted average at a gridpoint location

DIRSASS_k = new SASS direction solution

w_k = weight for the new solution

w_ℓ = weights for other solutions

Because there may be several SASS reports to be included in a particular SUPEROB, the SASS contributions are weighted as described above.

In Options 4 and 5 the wind speed and direction of a solution are transformed into the zonal and meridional wind components USASS and VSASS. These components are then averaged according to the same methods that are used for the speeds in options 2 and 3. The resulting averaged SUPEROB U and V are then transformed back to SUPEROB speed and direction. Thus:

$$\text{USASS}_\ell = -\text{SPDSASS}_\ell * \text{COS}\,(\text{DIRSASS}_\ell)$$
$$\text{VSASS}_\ell = -\text{SPDSASS}_\ell * \text{SIN}\,(\text{DIRSASS}_\ell)$$

For option 4, $(\text{SUPEROB U})_{I,J} = \dfrac{\sum\limits_{k+1}^{\text{NSASS}} \left(\sum\limits_{\ell+1}^{\text{NSOL}} w_k * \text{USASS}_\ell \right)}{\sum\limits_{k=1}^{\text{NSASS}} \left(\sum\limits_{\ell=1}^{\text{NSOL}} w_k \right)}$

$$\text{and, (SUPEROB V)}_{I,J} = \frac{\displaystyle\sum_{k=1}^{NSASS}\left(\sum_{\ell=1}^{NSOL} w_k * VSASS_\ell\right)}{\displaystyle\sum_{k=1}^{NSASS}\sum_{\ell=1}^{NSOL} w_k}$$

For Option 5, only the solution whose direction is closest to the guess wind field direction is used, so that:

$$\text{(SUPEROB U)}_{I,J} = \frac{\displaystyle\sum_{k=1}^{NSASS}(w_k * USASS_k)}{\displaystyle\sum_{k+1}^{NSASS} w_k}$$

$$\text{and (SUPEROB V)}_{I,J} = \frac{\displaystyle\sum_{k=1}^{NSASS}(w_k * VSASS_k)}{\displaystyle\sum_{k=1}^{NSASS} w_k}$$

Then, for both options 4 and 5,

$$\text{(SUPEROB direction)}_{I,J} = 270^\circ - ARCTAN \frac{\text{(SUPEROB V)}_{I,J}}{\text{(SUPEROB U)}_{I,J}}$$

$$\text{and (SUPEROB speed)}_{I,J} = \sqrt{\left(\text{(SUPEROB U)}_{I,J}\right)^2 + \left(\text{(SUPEROB V)}_{I,J}\right)^2}$$

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FNOC SUPEROB EXECUTION
(3 hourly cycle - SASS ± 1.5 hours)

```
┌─────────────────────────────────────────┐
│           Preliminary SLP Analysis        │
│                  (60 sec)                  │
└─────────────────────────────────────────┘
                     │
                     ▼
┌─────────────────────────────────────────┐
│           Gradient wind generation        │
│                  (2 sec)                   │
└─────────────────────────────────────────┘
                     │
                     ▼
┌─────────────────────────────────────────┐
│              Superob generation            │
│   (average FF/gradient wind DD-Option 1)   │
│                  (1 sec)                   │
└─────────────────────────────────────────┘
                     │
                     ▼
┌─────────────────────────────────────────┐
│     SLP/Marine Wind Analysis - NVA Balancing │
│                  (111 sec)                 │
└─────────────────────────────────────────┘
                     │
                     ▼
┌─────────────────────────────────────────┐
│             Superob regeneration           │
│ (Closest SASS ob to marine wind analysis-Option 5) │
│                  (1 sec)                   │
└─────────────────────────────────────────┘
                     │
                     ▼
┌─────────────────────────────────────────┐
│     SLP/Marine Wind Analysis - NVA Balancing │
│                  (111 sec)                 │
└─────────────────────────────────────────┘
```

Cycle as
advantageous
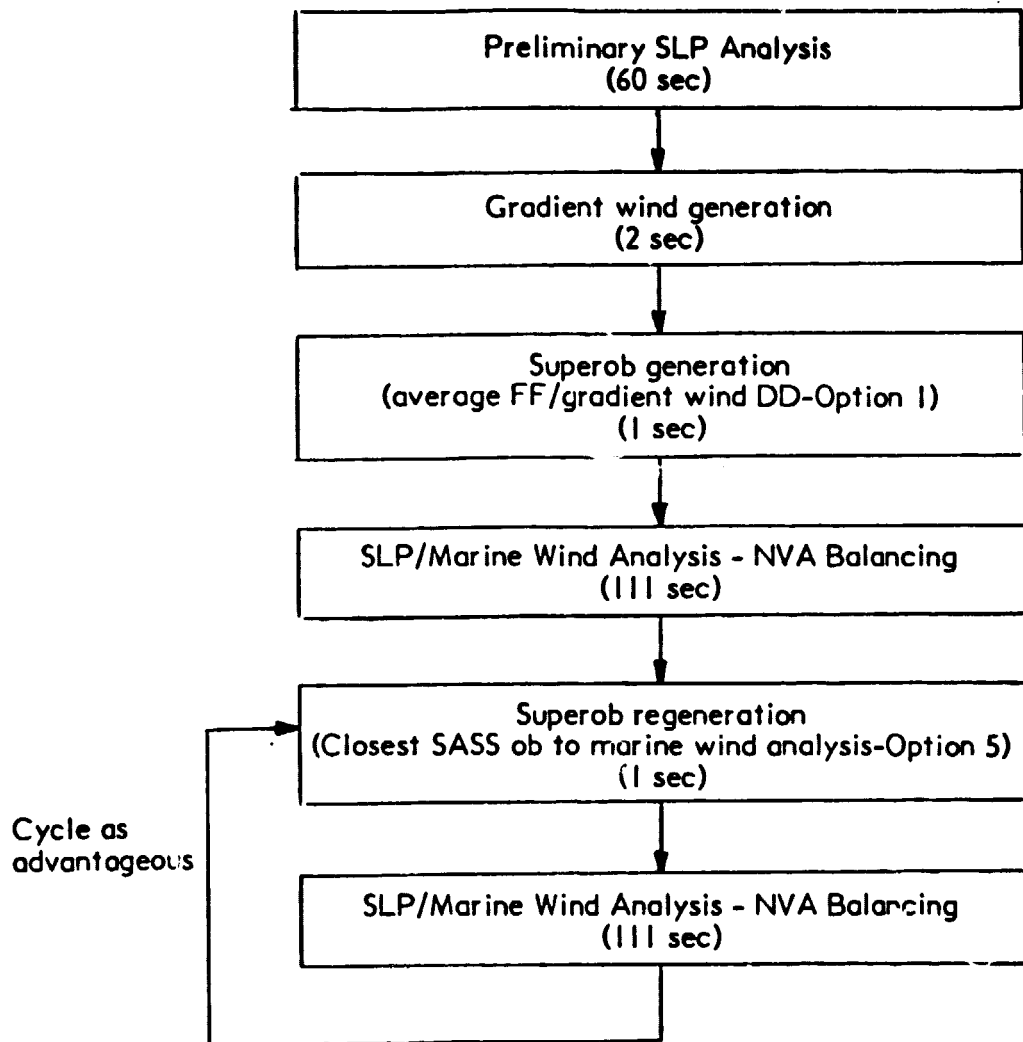
NOTE: (X) represents CDC Cyber 175 CPU time

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